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By

Robert Sandy, Ph.D.

December 10, 2018

In the case:

SCOTT TURNAGE , CORTEZ D. BROWN, DEONTAE TATE, JEREMY S. MELTON, ISSACCA POWELL, KEITH BURGESS, TRAVIS BOYD, TERRENCE DRAIN, and KIMBERLY ALLEN on behalf of themselves and all similarly situated persons,	)	**Case No. 2:16-cv-2907-SHM/tmp**
PLAINTIFFS,	)	**CLASS ACTION COMPLAINT FOR VIOLATIONS OF THE CIVIL RIGHTS ACT OF 1871, 42 U.S.C. § 1983, AND TENNESSEE COMMON LAW**
v.	)	
BILL OLDHAM, in his individual capacity and in his official capacity as the Sheriff of Shelby County, Tennessee; ROBERT MOORE, in his individual capacity and in his official capacity as the Jail Director of the Shelby County, Tennessee; CHARLENE McGHEE, in her individual capacity and in her official capacity as the of Assistant Chief Jail Security of Shelby County, Tennessee; DEBRA HAMMONS, in her individual capacity and in her official capacity as the Assistant Chief of Jail Programs of Shelby County, Tennessee; SHELBY COUNTY, TENNESSEE, a Tennessee municipality; and TYLER TECHNOLOGIES, INC., a foreign corporation	)	**JURY TRIAL DEMANDED PURSUANT TO FED. R. CIV. PRO. 38(a) & (b)**
DEFENDANTS.	)	

I was asked by the plaintiffs' counsel to opine on the minimum sample size needed to estimate the proportion of inmates in the Shelby County, Tennessee Jail who were held more than six hours after a court had ordered their release over the dates November 1, 2016 through May 30, 2017, and who had no other holds or detainers. Hereafter I will refer to being detained more than six hours after a court has ordered an inmate's release, with the no holds and detainers, as being "over detained". This estimate has a margin of error of plus or minus 3 percentage points of the true proportion with a 95% level of confidence. The level of confidence of 95% means that that procedure will include the true population proportion in 95% of all possible samples.

I was given one fact that I relied upon in my calculations. This fact was that the Shelby County Jail represented that the maximum the number of inmates held by the Shelby County Jail over the six months following the software conversion was 15,000. I will refer to this number as the "population".

Whether an inmate is over detained or not in a given jail stay is binary outcome, meaning that they are either over detained or they are not. There are some standard formulas for calculating the minimum sample size for any desired margin of error when there are binary outcomes. A key result behind these formulas is that the margin of error is as high as possible when the proportion in the population on either side of the binary outcome is 50%. Using the value of 50% as a planning value for the population proportion of over-detained inmates guarantees that the margin of error will either be equal to the desired plus or minus 3 percentage points or be less than amount.

The first formula is:

$$n_\infty = \left(\frac{z^2_{\alpha/2}\hat{p}(1-\hat{p})}{MOE^2}\right) \qquad (1.0)$$

Where n_∞ is the minimum sample size when drawing from an infinite population. The term "$z^2_{\alpha/2}$" is the square of the z-score from the standard normal distribution that has $\alpha/2$ area in the right tail. For a 95% level of confidence the z-score is 1.96. The term "$\hat{p}$" is the planning value for the unknown population proportion. For this jail problem I will assume the worse-case value of 0.5. The term "*MOE*" is the margin of error. This was specified by Attorney Mr. Brice Timmons as 0.03.

Substituting into (1.0) yields:

$$n_\infty = \left(\frac{1.96^2\ 0.5(1-0.5)}{0.03^2}\right)$$

$$n_\infty = 1168$$

Note, many introductory statistics textbooks only provide the formula for the first step, formula 1.0 above. Since the jail inmate sample will be drawn from finite populations it is important to use the formula that corrects for drawing from a finite population, formula number 2.0 below.

After determining the n_∞ you substitute that value into the second formula, 2.0, which accounts for the finite population correction factor.

$$n = \frac{n_\infty N}{n_\infty + (N-1)} \qquad (2.0)$$

The term *N* is the population size. The term *n* is the required sample size when drawing from a finite population.

$$n = \frac{1168 \times 15000}{1168 + (15000 - 1)}$$

$$n = 996$$

A sample of 996 inmates selected at random is guaranteed to have a margin of error of no more than 0.03 at a 95% level of confidence. Suppose the true population proportion was indeed 0.5 or 50%. That is the same as 7,500 inmates out of the 15,000 being over detained. The results of a sample of 996 randomly selected inmates will yield a sample proportion of over detained inmates between 0.47 and 0.53, or between 7,050 and 7,950 or plus or minus 450 inmates around the true count of over detained inmates in the population of 15,000.

Note, if the true population proportion was either higher or lower than the worst-case assumption of 0.5, then the margin of error will be smaller at the sample size of 996. The results are symmetric around the value for the population proportion of 0.5.

In case a sample of 996 is too costly, I also calculated the minimum sample size assuming that the true population proportion was 0.5, but with using a margin of error of 0.05 at the 95% confidence level instead of the 0.03. Increasing the margin of error reduces the sample size to just 359. This sample size reduction comes at the cost of a wider margin of error. With this smaller sample size, instead of being 95% confident that the true number of over detained inmates will be within plus or minus 450 inmates of the true number, the margin of error will be plus or minus 750 inmates out of the approximately 15,000 inmates who had stays in the Shelby County Jail over the dates November 1, 2016 through May 30, 2017.

One objective for collecting the sample of the original paper records is to establish that there are enough over detained inmates have them certified as a class. Suppose the assumption that 50% of the 15,000 inmates had been over detained was way too high. As an example, what would happen with the true over detention rate was just 0.05, or 750 inmates. If the threshold for certifying the class was at least 100 over-detained inmates, is there any chance that either the sample of 996 or even the 359 would yield an estimate for the population that less than 100 inmates had been over detained? The probability of having an estimate for the population of below 100 inmates for a 996 sample is 0.0000 while the probability for a 359 sample is 0.0001. If the true proportion of over detained inmates was just 0.025 the respective probabilities of having an estimate for the population of below 100 inmates for a 996 sample is 0.0001 while the probability for a 359 sample is 0.0122. Thus, there is very little chance that either size sample

would fail to yield an estimate that there are at least 100 over detained inmates, even with low proportions in the population, such as 0.05 or 0.025.

A second purpose of the sample is to estimate the number of hours beyond 6 that all of the over detained inmates among the 15,000 in the were held. This second purpose requires a larger sample than the what is needed for the class certification. The reason is that there is much more variability in the hours of over detention than for the proportion over detained. Some inmates were allegedly held for weeks after their court ordered release. Extremely high values of hours of over detention for even a few inmates raises the variability of the distribution of hours of over detention. The second purpose is why a sample in the 359 to 996 range is needed.

Robert Sandy

Dec 12, 2018
Date

Sworn and subscribed before me, Robert Sandy.

12/12/18

ELIZABETH OBDEUS
Notary Public, State of Rhode Island
My Commission Expires June 25, 2022